

Strain and stress analyses using diffraction methods have become increasingly important in the development and characterisation of materials, the optimisation of manufacturing methods (e.g. regarding surface integrity) and the assessment of component behaviour.

Due to the high photon flux and parallelism, synchrotron radiation offers novel possibilities for microstructure, texture and residual stress analyses.

Synchrotron radiation in the medium energy range enables investigations of the phase composition, texture and strain/stress state of the surface region. New possibilities are provided by beam focusing, thus local resolutions up to the sub-micrometer region can be reached.

High energy synchrotron radiation enables microstructure, texture and strain/stress analyses in the bulk of samples. Even in steel samples which have a diameter of several millimetres phase analyses and residual stress analyses can be performed with gauge volumes of only some μm^3 size. Due to the high photon flux analyses with high local resolution and time resolved in-situ analyses become feasible. In future even combined tomography / diffraction experiments may become feasible.

The increasing possibilities for microstructure, texture and residual stress analyses using synchrotron radiation are demonstrated by case studies. These include the surface of worn railway rails, friction stir welds, position and time-resolved in-situ experiments

Neutron diffraction techniques remain important complementary techniques to synchrotron radiation strain/stress analyses especially regarding coarse grained materials as well as components. Examples for experiments using neutrons and synchrotron radiation as complementary techniques are given.